ENERSTOCK 85

III International Conference on Energy Storage for Building Heating and Cooling

III[e] Conférence internationale sur le stockage de l'énergie pour le chauffage et le refroidissement des bâtiments

CLOSING SESSION

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ENERSTOCK 85
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Preface

The Closing Session of ENERSTOCK 85 allowed session Chairmen to report on their sessions. Later, delegates of the Council for International Thermal Energy Storage Conferences had the first opportunity to express their opinions on conference organization and other matters relevant to the development of storage technology. This Closing Session, like all others at the conference, was recorded due to the simultaneous translation requirements. I received numerous requests for a transcript of the session and one was produced afterwards. Such a transcript is rarely suitable for reproduction without considerable editing and this one was no exception. I edited the transcript into its present form. Inevitably some errors are introduced by this process, but I believe the improved readability justifies this course. I trust you will find the result useful in evaluating your participation in ENERSTOCK 85. This document is being distributed to all registrants.

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ENERSTOCK 85 Closing Session

Report from Session Chairmen

Chairman ENERSTOCK 85:

I have asked the Session Chairmen to report to the conference on their sessions giving an evaluation of the present state-of-the-art of the storage technology, problem areas, research needs, significant advances, and predictions of future trends. The Chairmen have had the Proceedings before the conference, have had the opportunity to listen to the presentations, attend the poster sessions, and discuss personally with the authors. They are in the best position to evaluate the sessions. We will take the sessions in order as they occurred, beginning with aquifers and ending with systems. Arne Boysen will report on the systems session.

Frank Hooper, please begin.

Chairman, Aquifer Session
Frank Hooper
Mechanical Engineering
University of Toronto
CANADA

I'm sure all of you appreciate the difficulty in summarizing something as varied as the subject matter of ENERSTOCK 85. There has been a wide variety of projects within the Aquifer Session. However, there are certain overall generalities and impressions, both positive and negative.

First of all the positive ones which were dominant. There has been a very substantial progress in most aspects of aquifer R&D. These include, significantly, the building and commissionning of systems and particularly the quality of the work. It has clearly advanced in the two years since our last conference in Stockholm.

The monitoring of system performance has been significantly advanced. We had far more reports on achieved performance and of operating characteristics than was available to us two years ago. There has been a very useful focussing on some operating problems, notably on water chemistry, on the causes of clogging and system design to overcome some of these operating difficulties. In these terms there has been a substantial advance in our engineering knowledge. I think too, there has been a much more realistic approach to the technical and economic factors. I believe that there was some rather higher level of wishful thinking associated with some of the work that we were hearing about two years ago. I believe a considerable degree of maturity is showing now. There has been an increased attention to the chilled water storage aspects of aquifer storage. And lastly, there has been a further advance in computer modeling of aquifers and the availability of models has been increased.

There have been things of which I would be somewhat more critical. There's work to do in terms of the economics of aquifer storage. I think this is a general concern expressed by a great many people here. We can all detect a lack of uniformity in reporting economics. We can't compare between countries or even between projects within countries, because people have been taking different bases for comparing. Design costs may, or may not, be included. Installation costs are variously dealt with, operating and maintenance costs are often guessed at or neglected. As a result, there is no high level of confidence associated with the statements of economic validity or lack of it. This is important to the ongoing progress and better defined economic assessments are needed in the future.

The long-term performance and stability of aquifer storage systems deserve increased attention. We can build them and put our equipment down the holes. But how long will it last? Is the aquifer itself going to be responding slowly and negatively over a period of time? Can we expect to use these for five years or fifty years, or for a hundred years and what kind of a design life do we have?

Some of the components needed for more general use of aquifers are missing. I think most countries lack, certainly in Canada and I know in the United States, appropriate legislation or law governing the use of the aquifer. We are likely to have erratic and unpredictable response on the part of the local authorities to proposals to use the aquifer for thermal storage. On the whole, I think the thermal storage use of the aquifer is benign. If it were well understood and well conceived, legislation could protect the public interest without interfering with the appropriate use of the aquifer for storage. But, at the moment such legislation as exists seems to be related to the use of the aquifer as a water source where water is mined from the aquifer. The notion of reinjection into the aquifer or closed circulation within the aquifer does not appear to have received attention.

Engineering standards for well construction and especially for injection well construction are in their infancy. We would hope to see more by way of developed specifications and recommended guidelines for that kind of activity. There were some comments on the need for better contracting arrangements. That may relate more to the development of more experience in the contractors who deal with this work.

However, overall my impression of the aquifer session was one of solid progress. We are seeing a good potential for economic use of the aquifer for storage and we are definitely seeing an increasing level of competence and expertise in those who are doing the work.

Co-Chairman, Aquifer Session
Jean Goguel
B.R.G.M.
FRANCE

Perhaps things are not so bad from the technological point of view, how to drill recruitment of wells and so on. We can rely on the know-how obtained in geothermal energy, which is closely connected with the question of heat storage. We have now experience in France of almost a hundred wells drilled for geothermal exploitation, some since more than ten or even fifteen years. As for the question of maintenance, we are now learning much about it and I think there is know-how on which we can rely.

I think a discussion must very clearly distinguish between high temperature energy storage, that is storage of heat at a temperature much higher than the initial temperature of the rock or the ground, and low temperature storage. For high temperature storage, there are strong differences with geothermal. On the chemical behaviour of the water and the ground on physical modeling, which is not at all a mere extension of geothermal modeling, but needs further research. We are now in France on the verge to learn much more with the two full-scale projects which have been described here. I hope the first results shall be available in 1987, but surely not a complete approved appraisal which needs a much longer monitoring. At least I hope many of you shall be able to visit this project at that time.

The low temperature storage is a different matter. Of course, we all know that heat pumps on ground water are working, there are thousands of them in different countries and they are working quite efficiently and they are economically sound. Starting from that, we may change something in the management of the cold source, that is the ground water, and it shall still be economically sound. The question is, we must check very carefully what is the effect of changing management, it may be heat storage, it may be anything else, and we must learn to be able to answer the question. What is the difference in cost and in efficiency of the same project with two different ways to manage the cold source in ground water? And only with a very accurate answer to this question shall we be able to see what it is wise to do about this ground water management.

Of course, for low temperature storage which implies heat pumps, efficiency budgets must not use the concept of energy or heat. It is nonsense to say that so much heat comes from the cold source and so much from the engine driving the heat pump. This is just a co-efficient of the heat pump. Comparison must be made with the exergy or the enthalpy concept. Dealing with heat pumps, I want to stress that there are two ways to look at them. They may be taken as a means to increase the temperature at which a given amount of energy is available. Of course, this costs some electric power, but circulation pumps also involve expense in electric power. This is one way to look at it. There is another way. We know that the future of energy depends strongly on nuclear power that can be available only as electric power. And we must learn to use electric power in the most efficient way. This is surely not the joule effect, it is through heat pumps. But heat

pumps have these defects that they need a cold source that may be the ground water or anything else. And it's only in theoretical thermodynamics computation that the cold heat source can be taken as free. We know that it is costly, but we have to make a wise choice to get the most economical management of the cold heat source.

This brings me to another question, which falls outside the field of our meeting. Let me stress that we have looked upstream from the heat pumps, but we should also look downstream, and downstream it is the heating devices. When we use heat pumps the cost of the whole device depends very strongly on the use of low temperature heating devices, what ever they may be. It is a very difficult matter, looking at the huge number of high temperature heating devices which are now existing which cannot be changed quickly. I think we should also feel concern with this side of the question.

Tony Gorski, Chairman of the Ice Session
Argonne National Laboratory
U.S.A.

Seasonal ice storage is an old technology now undergoing a rebirth of interest. Whether or not the end result of this rebirth is large-scale use by people in the Northern latitudes in the near-term future remains to be seen. Most probably we will only see small-scale applications by innovative, imaginative individuals and organizations. In the long-term future, it is my opinion that along with conservation and low technology solar these new ice growing techniques can have a major impact on our energy future. There are, however, three major problem areas associated with seasonal ice storage technologies. In terms of increasing difficulty, I believe they are technological, economic and social political.

Consider the social political problem area. Seasonal ice storage technologies are perceived many times as being too simple. The concept is simple indeed. Grow and store winter ice, winter cold in the form of ice and use it in the summer. It is a concept that the average man can understand and has heard or remembers from the past. Being in the past, it is perceived sometimes as being old-fashioned. And this is a modern high tech society. It may satisfy our summer air conditioning needs without compressors, power lines, nuclear fission or fusion reactors, but it is perceived to be a step backwards. This perception is now slowly changing. As with some solar technology the concept appears to allow one to become totally independent of power companies for air conditioning. Whether or not this is true, is of no regard, the concept as perceived by the electric utility, may be that of a new potential threat to the use of electrical energy. Several utilities are now playing a major role in facilitating the use of ice storage on a daily or weekly cycle. They have little or no role in promoting seasonal ice storage.

Another problem with ice storage technologies is that they were developed, for the most part, approximately ten years out of phase. If interest in seasonal ice storage had peaked during the oil crisis of 1973 and 1974 instead of ten years later, the situation would be no doubt different now. Many more installations would exist and the modern techniques of seasonal ice generation and storage would be more widely known. The growth of these

technologies is a testament of the hard work and dedication of a few individuals, only some of whose results you've seen here and are sitting among us in the audience. I'm speaking specifically to people like Ed Morofsky from Publics Works Canada, Landis Kannberg from Pacific Northwest Laboratories and Imre Gyuk from the Department of Energy.

The economic problems associated with seasonal ice storage systems are similar to those of most solar installations. The major problem being high capital costs. Seasonal storage of cooling energy in the form of ice implies large storage volumes. The cost of paying for thermal insulation is a major concern. The cost of conventional fuel is, of course, of major importance in determining the economic feasibility of the use of a seasonal ice storage system.

The technological problems associated with seasonal ice storage technologies are indeed simple compared to fission and fusion reactors, but they do exist. The problems vary with the method chosen for growing and storing the ice, and these problems are now being worked on and are all being solved.

At the first seasonal ice storage workshop in 1981, we tried to predict the future of ice storage technologies, we talked of space conditioning, and crop cooling, and the cooling of natural gas pipelines. But none of us predicted the explosive growth of diurnal ice systems. There are now about a hundred diurnal ice systems in the U.S. and Canada. None of us foresaw the cooling of commercial jet aircraft by means of ice, there are now some thirty installations in various stages of development. We were not imaginative enough.

I predict when we meet again in two years that seasonal ice will be in the market place, and we will be talking not so much of the ice forming technologies but the incorporation of these technologies into systems. No doubt at that time when I look back to today, it will become obvious to me, that I was not imaginative enough.

Michael Wiggin, Chairman of the Water Session
Canadian Centre for Mineral and Energy Technology
Energy, Mines and Resources Canada
CANADA

The comments I have result from discussion with my colleague and Co-Chairman Robert Cohen. I think one of the biggest benefits of this conference is the opportunity to get together with your colleagues and brainstorm over a beer and resolve problems. This has been of immense value to us. The ongoing opportunity to periodically do this with a broad cross section of people should not be underestimated. I think this is one very valuable role of these conferences that we should not undervalue. Hopefully we will continue to have this opportunity for technical exchange.

One thing I noticed in the water session papers is that there seems to be a higher level of confidence in the different technologies. We can now talk about how they work and we are starting to get a better handle with the economics. As we get this confidence within the storage community, we can

convey it to those who are instrumental in seeing such technologies put into the market place, such as consultant engineers, architects and others. I also was very pleased in the studies and modeling section of the presentations, to see the degree to which we're getting almost design manuals, for heat loss from tanks and various modeling tools available now. As these are available and are passed onto the consulting engineers, they can pursue storage as an option to incorporate into energy systems with much more confidence. I think it's important that this material continue to be made available.

In many of the papers - some of these comments apply to all of the sessions - we frequently heard comments such as, well the next time the size might be reduced, or if they did it again they could reduce costs on different components, the construction techniques could be improved and simplified. There should be more of a focus on these cost reduction opportunities in the future, perhaps by ensuring involvement of contractors, mining specialists, and others. Maybe it would be useful to ask project leaders on some of the projects presented here to make available more information in retrospect, looking back at their projects to see what opportunities there would be for lowering the cost for future installations. If we can learn from each other on these cost reduction techniques that would be immensely valuable.

One very interesting type of storage in our session, was what I would call opportunistic storage. I think Peter Kjaerboe did an excellent paper on heat extraction from abandonned and water-filled mines. If we can look for early penetration of storage in any sector, the overall credibility of storage increases. If we can put a little more effort into looking at some of these low cost sites, specific opportunities that are available, pulling together more information to help people outside the storage area develop better appreciation of what to look for, I think this will accelerate the penetration of storage technology. Perhaps, we might try to encourage more papers on this particular subject at Enerstock 87.

There were also some excellent papers on short-term, diurnal, cost-effective technologies. Many of these, in all our countries, have almost become matters of standard engineering in commercial buildings. We should try to encourage more of this nature of paper and make sure that short-term storage remains part of the overall storage activity. It makes it a lot easier for the rest of us in other areas to get support and see our technologies flourish as well. Perhaps, it would also be useful to try and encourage people working on some of these short-term technologies, like Robert Cohen on my left here, is doing with the use of small-scale storage technologies to enhance the effectiveness of boilers in buildings. We should get these papers put out more often through other forums and other conferences. In Canada we should use the Canadian Boiler Society and similar groups to spread the word on some of the opportunities that are available.

Like district heating, an area in which I'm a little more involved with than storage, the economics may appear to be somewhat marginal. What really catches the imagination of our municipal officials and others are some of the other benefits that come forth. I think we have to start developing more of this information. Many of the papers did contain this in certain circumstances it might be beneficial for fire protection, reasons to have

water storage available, this varies from country to country depending on their laws. You might avoid costs of condensers for example on equipment. There are environmental benefits. Perhaps storage to help lower the cash flow out of the community for purchasing energy and putting money back into the community for capital investments on ongoing jobs. This is something that is very popular with our municipal officials. It would be very useful to ask authors of future papers, to document some of these benefits they've seen that help their projects go and perhaps even look back over the projects they've got and document benefits that have helped make these projects worthwhile. If we can pull these all together, that helps us refine our marketing technique, these are often factors that help make storage go.

Much of our heating and cooling load is in urban centers again like district heating. However, we haven't got nice open fields to build our experimental facilities. In the long-term, we must adapt some of our storage technology to fit more readily into the urban centres where it's likely to be applied. It would be interesting to see more work on how to incorporate storage into the planning of communities, how it can be incorporated into existing communities.

In wrapping up, I think it's been a very profitable conference, the feedback was generally good and I thank you for your participation.

Robert Cohen, Co-Chairman Water Session
School of Mechanical Engineering
Cranfield Institute of Technology
UNITED KINGDOM

I haven't a lot to add to what Mike said. I think we all know that water has nearly always been recognized as being extremely benign, almost free, high heat capacity and all the other obvious advantages that it has. I think from this conference we've seen that its been subjected to new tests in the last few years. For instance in large rock caverns, and problems of mineralization and bacterial growth have been tackled. I think from the papers that have been presented the reputation of water has come through untarnished. Clearly we should note the precautions that need to be taken and draw on all the experience that hydrologists and water engineers have built up over the last century to effectively avoid any problems of clogging in heat exchangers and so on around the system.

Otto Svec - Chairman Duct Session
Division of Building Research
National Research Council of Canada
CANADA

I think overall, our day on duct storage was very successful. There were a lot of very good papers. We had many reports on impressive installations, particularly coming from Sweden. We heard criticisms on whether these installations are really cost effective. Since most of them are experimental, I don't think that's the major point. After evaluation, these designs could be revised and maybe an optimized solution achieved. An economic evaluation should then be performed on these optimized designs.

We had papers presenting models for heat and moisture transfer. The determination of the diffusivity function is still a problem, particularly the question of drying, rewetting, and shrinking in the case of clays, for example. We had papers with analytical formulations where formulas were derived. I think these are very, very useful especially if you realize that you have to solve or simulate the whole system hour-by-hour for maybe three years or so. The only comment I might have is that perhaps these formulations, because they are trying now to derive the formulas for geometrically complicated systems, should first be compared to detailed finite element analysis and then to lab models and full scale experiments. In steady state and particularly in transient situations, I'm not quite sure how they would work. I think that validation is needed.

We saw some innovative ideas, such as using soil air as a heat source for heat pumps. Such techniques can have double benefits in helping to solve environmental problems associated with radon gas. Nice paper on the Suncourt project in Sweden. I like the idea of trying to find other benefits, not just simple dollars. I think consideration of conservation, and aesthetics or environment all together are very important, social problems as well. We should not look exclusively at dollars. I think other things are important, like dependancy on foreign sources of energy and, of course, pollution.

The next point has been mentioned several times here and I would like to stress it even more. We should develop some unified evaluation system for costs and unified methods of evaluating performance such as heat extraction rates per running meter of a heat exchanger and also for the entire storage system with connections and distribution. That should be developed in such a way that various systems have common denominators. You would know which system really works.

I would like to close my remarks with the statement that I would really like to see a stronger cooperation among all of us and among countries, particularly whether it's through bilateral agreements or IEA projects. I think we can learn from each other and certainly the benefits are there.

Soren Andersson, Co-Chairman Duct Session
AIB Consulting Engineers
SWEDEN

I would like to stress the importance of long active evaluation works. We have heard today about many storage projects, most of them were designed some years ago based on a level of knowledge probably far below what we have today. So, the evaluation project should not only include measurements and calculations of efficiency figures and so on, but also include at least theoretically a redesign and optimization of the plant based on what we know now. I hope that we will see much more of this in the future. This should also be done for the ice, aquifer and water systems. This might be a point for the next conference where many more projects will be in operation and hopefully evaluated.

Arne Boysen -- The Systems Session
Operating Agent for IEA Task VII
SWEDEN

The first point I would like to take up is the point dealing with the organization of this conference. I noted that in the Systems session today, not all of the papers really dealt with systems. But on the other hand, systems were presented also in other sessions, so I do believe that systems were very well covered. My observation only indicates the problems of the organizers, which all organizers of a conference like this experience, to find the proper place for all the papers.

I tried to make some very simple statistics from the papers in the session today. What I was most interested in was the level of operational experience reported. I found that if I divide the papers in three classes, one class of papers reporting several years of operation, an intermediate class of papers representing up to one year of operational experience, and the third class of design studies. The number of papers were relatively one to two to four. This indicates that roughly, fifty percent of the papers cover practical applications of storage. This is very big progress from the conference we had two years ago and it really supports the confidence that has been reported from some of you in the design methods you are using.

The papers, and also very much the discussion, underlined the problems of how to find and how to select a good system concept. Do we want heat pumps or not? Do we want low temperature distribution or high temperature distribution? Do we want small or large systems? I do not dare to try to draw any conclusions of the discussion today but one of my Swedish colleagues, Goran Hultmark has promised that he will risk his neck and present to you some of his reflections on this topic.

Goran Hultmark
AB Andersson . Hultmark
SWEDEN

I just wanted to talk a little bit about the technical systems design which were presented today. One interesting design deals with a phase change, and that is the only design that isn't dependent upon temperature. Therefore, an analysis could be divided into sizes. For single family houses it seems that still no one is working with high temperature storages. All designs deal with heat pumps according to longer term storage. Most are water storages, but also latent heat and using building components as storage. Going to bigger projects, they are divided into three levels. One low temperature level of under 40°C, one medium temperature up to 70°C, and one high temperature up to 100°C.

For the low temperatures, seems that it's quite uniform, the heat pump is used or unglazed collectors, single glazed collectors or wind convectors and there are always the cheap storages, such as cheap duct systems or aquifers involved in those systems.

Going to what I call the medium temperature range up to 70°C, there are systems both with and without heat pumps. For example, Groningen without heat pumps. There are also different kinds of collectors, from flat plate to evacuated collectors, and there are water or ground storages. This group is by far the most complex group of those three. Because coming to the high temperature group, the group which is just under 100°C there are no heat pumps involved, there are high efficient flat plate collector, evacuated or concentrated collector and there are water storages involved.

Arne Boysen -- again

One of the things that has been said by the commentators now has been the need for some common bases in order to compare different systems. This is something that the IEA Task VII tries to give you. I would like to underline that such data and such design tools have to be continually updated. Cost data quickly becomes incorrect. The development goes much faster then we anticipate and these design tools should not be relied upon for the final designs. If you want to do any real designs you should not trust international values which have been agreed upon in groups such as the IEA. You have to use national values. You have to use site specific values. Only then you might find some true solutions. But the methodologies of these international projects may be used. The methodology offers this common basis for comparison that was requested.

We have seen today during this conference the effect of having a substantial funding on full scale experiments. I refer to the Swedish research program. I have to congratulate the Netherlands. They have taken up the experience and are now working with a research program that has a substantial budget for full-scale experiments. We have seen, and you have seen demonstrated during this conference, the vast amount of experience and knowledge such philosophy generates. I do hope that the Netherlands is not the only country that will take up this practice and that we will see a lot of full-scale experiments also from other countries.

Report from the Chairman on the Council for International Thermal Energy Storage Conferences

A significant event took place at ENERSTOCK 85, when a resolution was passed by the Conference to establish a new body, the Council for International Thermal Energy Storage Conferences. The primary function of the Council will be to assure the orderly continuity of the International Conferences. ENERSTOCK 85 is the third international energy storage conference held to date. Previous Conferences were held in Seattle in 1981, and in Stockholm in 1983.

There was general agreement among the delegates that these International Conferences are filling a very clearly felt need, and that formalization of the process for selecting meeting sites is indicated.

The actual resolution passed by the Conference is given below.

> "This Conference resolves that a Council for International Thermal Energy Storage Conferences shall be hereby established.
>
> The Council is authorized and instructed to arrange for the continuity of the Conferences at regular intervals by arranging for and designating, several years in advance, the countries and years in which future meetings will be held.
>
> The Council shall also act to facilitate the transfer of information from the officers of one Conference to those of the next, and generally to promote the success of these Conferences and the advancement of the science and technology of thermal storage.
>
> The Council shall establish its own Constitution, which will assure that its membership will include representatives from those countries in which there is a substantial interest and activity in thermal storage, and that these representatives shall be appropriately selected. The Constitution will provide for the election by the Council of its own officers, except for its President, who shall normally be the General Chairman of the preceding Conference, and who shall hold office until the close of the following Conference.
>
> The Council, having designated the time and place of a Conference, shall have only an advisory function. Full responsibility and authority for the organization and conduct of each Conference shall be vested in the host organization."

Edward Morofsky
Chairman ENERSTOCK 85
CANADA

I'd like to congratulate all the Chairmen for their very good performance under tight time schedules, and I congratulate myself for choosing such worthy Chairmen. I will as a matter of course, be making a written summary of this Closing Session. It will be interesting to review it in Paris in two years and compare it with reality.

Next will be a short report on the Council for International Thermal Energy Storage Conferences that was established at this meeting. Let me tell you some of the people who are now delegates, from the Technical University of Denmark - Bjorn Qvale and Preben Hansen; from Poland - Miroslaw Dytczak of the Warsaw Polytechnic; Bernard Matthey of Switzerland, Operating Agent of Annex III of the IEA Storage Program; Landis Kannberg of the Pacific Northwest Laboratory in the United States; for the Netherlands, G.J. van Mourik of the Management Office for Energy Research and A.L. Snijders of the Heidemij Adviesbureau B.V.; Arne Boysen and Sven-Erik Lundin of the Swedish Council for Building Research; Professor Nir from the Institute of Desert Research in Israel; and Professor Frank Hooper of the University of Toronto.

I will find someone from China to be on the Council and from Japan perhaps the General Manager of the Tokyo Electric Power Company. Volkmar Lottner of KFA Julich in the Federal Republic of Germany promises to give me a name, although for today he is our delegate; and for France as well, Jean Goguel is our delegate for the present. If any other countries wish to be represented, I would ask them to contact me.

Now for a very brief outline of the plans for this council. I would hope within the next year to have a site and time for what will be Enerstock 89 or 90. I think it is only in that way, with at least three years notice, that we can do a rational conference organization. So you would know before ENERSTOCK 87, where the subsequent conference will be. The program can be finalized in Paris with input from Council delegates. Any final problems can be ironed out in Paris. I think that will be a great improvement.

I will make some attempt to lure other countries who have programs, or maybe should have programs, into this International Co-operation and I might ask you for assistance. In doing that we will, of course, take up Chin Fu Tsang's offer and use his STES bulletin to communicate effectively amongst ourselves and the storage community. With the longer lead time, we can give authors some commonly accepted format to present costs and other data so that we will have an easier time in comparing different projects and different concepts. Between conferences specialty workshops can deal with subjects requiring closer attention.

Report from Council Delegates on their evaluation of ENERSTOCK 85 and suggestions for future conferences

Edward Morofsky
Chairman ENERSTOCK 85
CANADA

I will now ask the Council delegates to give their evaluation of this conference, any suggestion as to the structure or timing of future conferences, and general comments about future requirements for the development of energy storage technologies. We will start with France - the next host country - and end with Sweden, the previous host.

Jean Goguel
B.R.G.M.
FRANCE

Au nom des participants à cette deuxième réunion de énergie store et spécialement des participants français et des participants étrangers francophone, cette un honeur particulier pour moi et un privilège d'avoir a exprimer nos remerciements à nos hôtes canadiens pour le receuille et les excellentes conditions de travail qu'il nous ont fournis, donc en telle organisation matériel de la publication des communications et des résumés. Et j'anticipe sans hésiter, pour l'organisation des visites qui auront lieu demain et je profite de l'occassion pour remercier également les interprètes de leur travail.

Le champ de notre activité est un domaine en évolution rapide. Beaucoup de recherches entreprise sous la pression de la crise de l'énergie, commence seulement à porter leur fruit. Il est essentiel que les équipes qui travaillent dans les différents pays puisse échanger leur expériences et passer en revue ce qui ce fait ailleur. L'intervale relativement court de deux ans entre nos réunions successive est actuellement parfaitement justifié et je suis sure d'après ce que nous avons entendu ici, que dans deux ans nous aurons beaucoup de chose nouvelle à apprendre. Je souhaite donc, à tous les participants de pouvoir se retrouver en France, dans deux ans, pour poursuivre notre travail, que nous nous efforcerons de rendre aussi agréable et fécond qui la pus l'être ici.

G.J. van Mourik
Management Office for Energy Research
THE NETHERLANDS

Maybe some points that can be useful for organizing the next conference. I think that the organization of this conference was excellent in the way that the conference was divided in parts, each to the type of storage, aquifers and duct systems. Also each type of storage and type of system was divided into sub-sessions on performance, design and construction, and modeling. I personally found that it was a very good thing to do so.

A second point is the presentation. Each presentation had a limited time of seven minutes. I think that some projects are suitable for a presentation of seven minutes, but there are also projects which can't be presented in seven minutes. Maybe for the next conference, for example, one major aquifer storage project carried out in the world can be used as a case study and can get more attention. Perhaps half an hour with some discussion totaling one hour. Then you can get more information about the details of such a project that is not possible in seven minutes. And after such a project case study, the results can be presented in seven minutes, of course.

I think that a poster session or maybe an exhibition is very useful in connection with a conference. They serve a very necessary social task. You can meet and talk to people there.

Furthermore, I think that maybe there can be some more answers on international projects. International cooperation is very important to my opinion. Maybe in someway or another in a conference there can be some attention or some emphasis on international cooperation.

Another point can be that, for example, you take one subject, market potential for different systems. Not much has been said about market potential for different systems in this conference. Ask each country to give their view on such a specific item. Maybe that can work out very well. When the conference is organized together with the geothermal conference, then maybe there can be some attention that the Aquifer and Geothermal Sessions are not in parallel. When you are interested in geothermal, you are also interested in aquifer storage.

I leave my suggestions, of course, to those who organize the conference, but maybe there are some I made that will be useful to you.

Landis Kannberg
Battelle Northwest Laboratory
U.S.A.

I have just a few remarks. First of all I'd like to offer the organizers of this conference my congratulations. I think they've done an excellent job, both in the organization and in the execution of the conference. I look forward to the conference in 1987 in Paris. I think it will also be a good conference as long it has the commitment that this conference has had. The various people who have attended and presented papers have offered a significant contribution to the continued development of the technology.

In terms of what might be done to improve on the conference, I personally liked the short presentations. They give authors a chance to focus on the important elements of their talks. I would agree that it might be helpful if the sequence of papers might be somewhat altered so that papers on a common project or theme, presuming there are a number of them, might be collected in a sequence.

If at all possible, I would hope that there might be a panel discussion on the various types of storage consuming perhaps the last half hour or forty minutes of each of the sessions, thereby permitting some open discussion of topics that are of critical interest within that particular technology. I think we saw a little bit of that today when we were discussing some of the system issues.

I would hope that the conference in Paris would include again a session on ice storage. It is perhaps not of critical interest in Europe, but is in the United States and in Canada where they are a significant source of both seasonal and diurnal storage systems.

Bjorn Qvale
Technical University of Denmark
DENMARK

To me this conference has been very successful and a logical successor to the meeting in Stockholm. It has been very interesting. It's obvious that we have reached the age of maturity. I think that it has also been presented with modesty and realism, as opposed to maybe former meetings.

One thing I missed at the Stockholm meeting and which I still miss, and that is company, because we in Denmark are studying conventional systems into which we want to incorporate thermal energy storage. Most of the papers that have been presented, have studied the incorporation of thermal energy storage into future systems based on some technology that might not be very attractive in the intermediate cloud covered countries of northern Europe. I think that the immediate economic significance of thermal energy storage might be when we are using conventional technology. I'd like to encourage people to look at that when they are running their pilot plants. I'd say though, that the number of evaluations of systems and the performance of systems and the economics of systems has risen tremendously since the Stockholm conference, where they were practically absent.

The efforts in the immediate future will probably continue to centre on the collection of experimental data and experiences. Until thermal energy storage is accepted in general, as a technology, I think that the number of full-time researchers engaged in it will dwindle. There will be part-time workers, I think I see that in Denmark, they'll be operating certain plants but the number of full time people engaged will be dwindling. So it's extremely important that a Council has been formed for the future of this effort. So, I think that may be the only way to save the future of this conference. I'm very happy that this constructive idea was put forth.

One thing I think should be done in the meantine until we meet in about two years, which has improved quite a bit over the last three or four years, is we should try to communicate in between conferences. Through the IEA we have actually made lot of personal contacts so the information has been flowing reasonably quickly. But when we are turned into part-time workers, then we should make an extra effort to maintain this flow of reciprocal information. I believe that's all I want to say and I believe strongly that we shall meet in France in two years. I'd like to believe that.

Volkmar Lottner
Kernforschungsanlage Julich GmbH
FEDERAL REPUBLIC OF GERMANY

First of all, I would like to congratulate the Chairman of this conference, Ed Morofsky and all the other session chairmen for this very good conference. I think several things were very important for this success to my opinion.

The first is that the conference proceedings were available at the time of the conference. One could look in the papers and read through this information. Second point, is that to my opinion, the form of the presentation was very good in that talks were split into short oral presentations of seven minutes. This is sufficient to summarize the most important points of the work and to give more information in the posters. Therefore, I would like to recommend that this could again be followed in the next conference. Perhaps to give a broader overview of the work it might be useful to have some review invited papers on special topics.

Of course, I think it's very important that the results and information which are available in the different countries will be communicated partly by direct contacts but also via conferences like ENERSTOCK 85 and also via the IEA groups which deal with energy storage and solar energy.

Aharon Nir
Institute of Desert Research
B.G. University of the Negev
ISRAEL

This was a very informative and useful conference. That was stressed by all previous speakers and I believe they convinced all our chairmen about this fact, so I'm free from reiterating this point.

However, everything in life has some way for improvement and may I suggest something as well. I believe that we had in various fields presented in this conference and multitude of approaches which were presented in different terms, different background and different language, so what I would suggest is to have invited review papers for each topic. Examples could be for theory, storage installation technology, for systems, for economics, and so on. I would propose a session on the future technology effect on our subject of interest, just as an example.

Now, I know it's somewhat difficult to do it at short notice, you may have only a few weeks to do this, to look at the papers coming at the conference and it's sometimes difficult, somewhat sensitive to criticize our colleagues, but this is done at many conferences. Many of you are probably witnessing this at other conferences and I would recommend this to be a very good step to focus our attention at the real differences, similarities, and duplication which is sometimes important for verification at the innovation in certain of the papers that we have here. So, I would very much appreciate if this proposal would be considered by your council.

Arne Boysen
Operating Agent of IEA Task VII
SWEDEN

I have very little to add to all these excellent suggestions for the next conference, but I would like to add one small thought for the conference after that. This concerns the timing of the conferences. I believe, and quite a lot of my colleagues agree, that two years may be a good interval between the conferences at the start of the development as we have been so founded. Sooner or later, we will have to reflect on these intervals. Will we want to continue with two year intervals or to prolong the interval between the conferences to three or perhaps four years.

This is something that perhaps is not valid for the next conference, but let me take this opportunity to suggest that this be discussed for later conferences and that we then can have a plan for a series of conferences which we can focus upon.

Being one of the last speakers at this conference, and also being in the very unique position of being the organizer of the last conference, I would like to take this opportunity of really thanking Ed Morofsky, the Chairman of the Organizing Committee, his members in the committee, not least Herb Graves and his assistants in the Intertask Limited. I think that the organization has operated smoothly and excellently without any problems at all. It has been a good conference. It has been the right size of a conference. We have had quite a lot of opportunities to meet friends, to exchange experience and to proceed in all fields.

So, ladies and gentlemen, I hope that you will join me in thanking the organizers of this conference.